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FOREIGN TECHNOLOGY DIVISION

CAPITAL CONSTRUCTION IN NEW CHINA

(Selected Portions)

by

Chen Ping, Liu Guodong, Qin Wen

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(Selected Portions)

By: Chen Ping, Liu Guodong, Qin Wen

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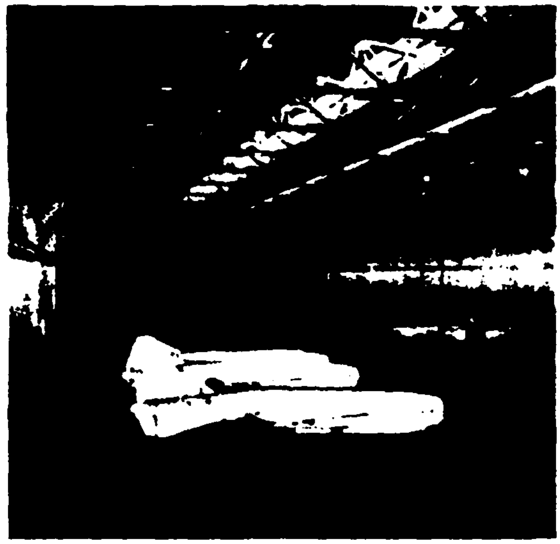

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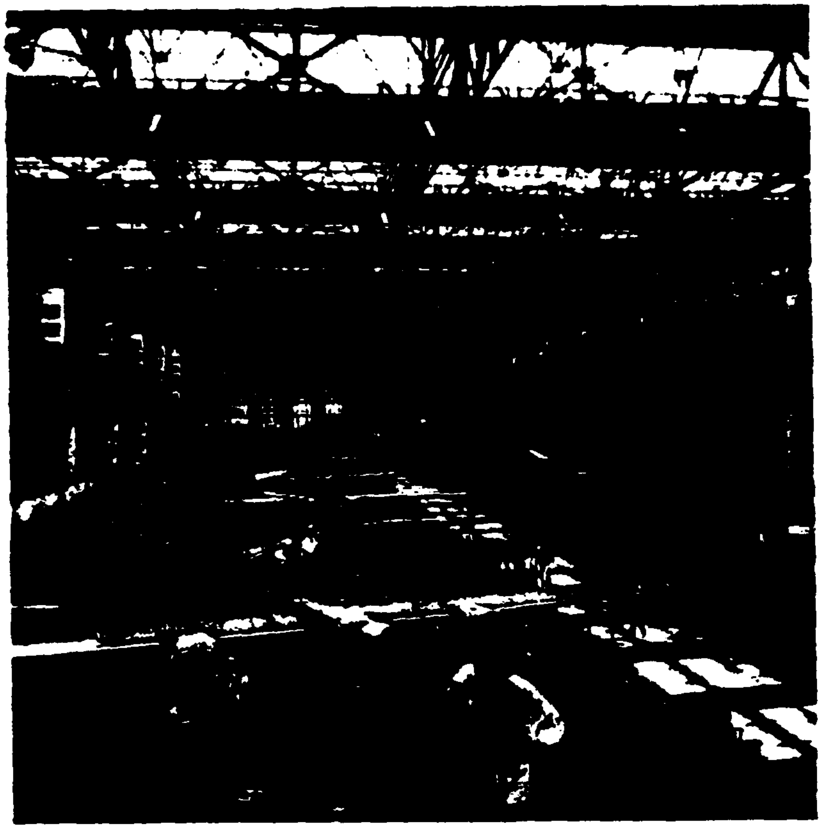

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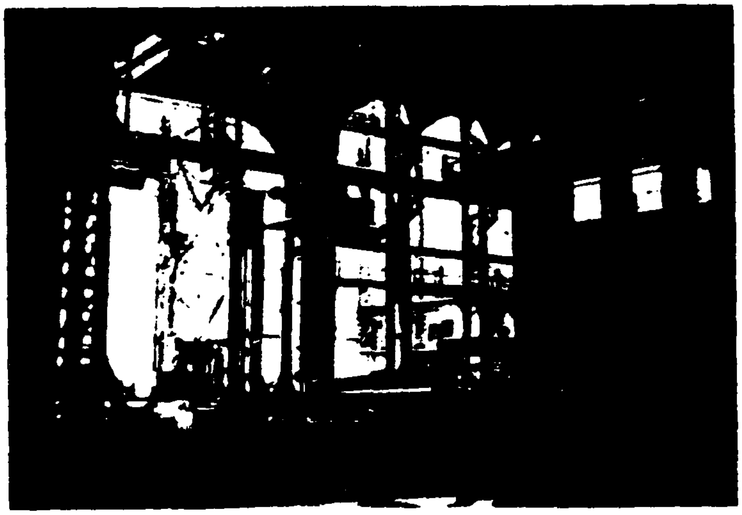

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IMPORTATION OF TECHNOLOGIES; IMPROVEMENTS AND INNOVATIONS [Page 67]

Beginning in 1977, and especially since the third plenary session of the eleventh central committee of the Chinese Communist Party, the aviation industry and its capital construction have been in a new period of improvement and innovation.

The destruction of the Gang of Four in 1976 put an end to a long period of political turmoil, but the national economy was in a state of serious imbalance and abnormal operation, which had not yet been remedied; adjustments were urgently required. Although at that time "leftist" thought continued to play a leading role in the thinking in every field of activity, the aviation industry, under the slogan "up with scientific research, bring in new technologies, wipe out the seven," tried to accelerate every aspect of the Four Modernizations, repeatedly drawing up enormous programs and plans. These plans, considering that at that time the country had neither the financial or physical resources to match them, were still very much divorced from reality.

In the latter part of 1978, the historically significant third plenary session of the eleventh central committee of the Chinese Communist Party rectified the nation's course and began to undertake a comprehensive correction of mistaken "leftist" deviations. Moreover, it set a policy of "adjustment, reform, reorganization and improvement" for the national economy, and it cut back severely on capital construction, requiring that the industry do only what it was capable of doing.

As for capital construction in the aviation industry at that time, there was a large organization behind it, with many irons in the fire, many debts, and low profitability. Only after sorting out construction projects and postponing or abandoning projects which were beyond their ability or which were presenting many difficulties were they able to place the entire scale of capital construction on a more reasonable foundation. At the same time, they shifted the priorities from new construction and expansion to technical improvement. They also adjusted the direction of their projects: the

organization of projects and the distribution of investments now was focussed on the principle of first conducting scientific research and encouraging research and development for new planes. During this period of time, the main types of work which were carried out were the following:

1. Large-Scale Introduction of Foreign Technology and Equipment

Long-term national isolation had a strong negative influence on the progress of technology. When the Cultural Revolution came to an end in 1976, the scale of the Chinese aviation industry was large, but the technological gap between it and the aviation industries of foreign nations was even greater than in the past. After China opened up, the introduction of advanced foreign technologies to shrink the gap without delay was obviously needed if we were to have a modern aviation industry.

In 1977 the importation of the manufacturing technology for the Sibei turbofan engine was a very important project. For the project, the Shaanxi Engine Factory and ten related auxiliary engine factories carried out varying levels of technological modification and expansion, and imported a large amount of modern supplemental production and testing equipment. Some of this equipment was state-of-the-art at the time. These factories, which had been constructed in the 1950's and early 1960's, had replaced very little of their old equipment with new equipment. This project, with its introduction of new technologies, raised the level of both the equipment and the technology. In 1980, the Sibei engine was successfully test-manufactured.

The landing wheel brake inertia testing platform, which was imported at the same time, provided very important testing techniques for basic research, product quality improvement, and modification of the brake system. This platform included large-scale testing equipment of an advanced international level. After being installed and debugged, it was approved and put into operation in 1984.

The model 7760 main-frame computer, bought from Siemens, was the principal computer for the Xibei Computer Laboratory. After the facilities in which the minicomputers there had been housed were modified, this large computer was installed and was quickly put to use, with many tasks to perform.

The 100-point coordinated loading detection system, imported for the Airplane Strength Analysis Laboratory, uses a computer to control the exterior loading work of the testing process. It incorporates automatic mobile measurement and automatic processing of test data. The old method in which over 100 persons at separate positions were responsible for manual loading, with flag-waving and whistle-blowing to direct the process, and the obsolete, wasteful manual data-processing method, have been made several thousand percent more efficient. All this indicates a qualitative change in the testing methods, as well. The importation of this kind of equipment has solved key problems and has proved to be very useful.

The flight test real-time data system which was imported for the Flight Research Laboratory allows the data which are generated during the test flight to be immediately transmitted to a ground station. The ground station can observe the dynamic process of in-flight tests, and this greatly improves the effectiveness of testing. For many test flight projects, this type of real-time data is indispensable. Moreover, the ground station can respond at all times to the situation, adjusting in-flight testing and issuing supplemental or modified commands, and can thereby avoid the discovery after the flight that the data are insufficient or irregular, which would require additional flights and tests. This system has greatly raised the level of the laboratory's remote sensing, telemetry, and remote control.

In 1980, China signed an agreement with the French Aerospace Corporation for the transfer of the production technology for the Dolphin helicopter. The priorities for this project included the rebuilding of four main aircraft factories in Heilongjiang and Hunan Provinces, and of two supplemental factories (e.g., a propeller factory), in order to satisfy higher production and testing requirements with respect to composite materials, hot work

techniques, and so on. By the end of 1985, 102,000,000 yuan of public funds had been invested. By 1985, the technological improvements of the main project had already been basically completed; the machining and assembly capabilities for the aircraft, the engine, and the main and tail decelerators were available. Moreover, helicopters had already been manufactured with partial use of materials and components supplied by the French, and had been handed over to the departments for which they were intended. Afterwards, the percentage of domestically manufactured components was gradually increased.

Units like the Xian Aircraft Factory carried out machining and manufacturing of certain foreign aircraft components, using the original materials and diagrams. From this activity, they acquired relevant skills and technologies. Using funds they had raised themselves, they improved our techniques in areas like hot work, which had been weak links in our technology. This approach costs little; it is highly focussed, requires little time, and offers great technological benefits. It is highly recommended.

The goal of these technology importation projects is mainly to reduce the technology gap and to engender a spirit of self-reliance. The construction projects which are carried out in coordination with these usually account for less than ten percent, and never as much as twenty percent, of total investment. Nevertheless, they are quite complicated; examples include the large-area hangar for the installation of the aircraft testing real-time data system, the construction of the Sibei engine test-run platform, and the engineering for the foundation and installation of the engine strength testing equipment. The Capital Construction Department, in order to meet the schedules set by agreement with foreign concerns, and under urgent constraints of time, makes every effort to meet all requirements.

2. Improvement of Facilities for Research and Development and Education

The improvement of research and development methods and the restoration and expansion of educational institutions were some of the most urgent

problems following the end of the Cultural Revolution. Because of this, after 1978, capital construction investments budgeted for the Aviation Industry Ministry have been mainly used to build up the system's research and development and education units.

Although the Shenyang and Sichuan Aircraft Research Institutes were established many years ago, their standards and testing methods were very poor. Only recently did they begin to implement important improvements and construction and create the necessary conditions for developing two new fighter plane models.

The Xinan Engine Research Institute's core engineering high-altitude simulation test-run platform is a crucial means of testing an engine's in-flight performance. It is absolutely necessary for the independent research and development of China's own engines. This test-run platform incorporates very complex technology. Its design was discussed and debated for more than ten years. In the late 1970's, advice was sought from foreigners and similar foreign test-run platforms were studied. The design was completed by the Fourth Planning and Design Institute, and it has already been ranked as one of the country's main engineering projects; the machining of the equipment and the construction of the project are accordingly being expedited.

In order to conduct tests on emergency ejection equipment, the Lifesaving Research Institute needed a rocket-propelled vehicle, with the appropriate rails, to move at speeds approaching and exceeding the speed of sound. Because the vehicle will travel very fast and has a large overload, the rails must be perfectly straight and level. Thus, this project is very important and highly challenging. Preparation for the project has gone on for a long time; at present, the design work is basically complete, and construction is in the active planning stage.

Educational facilities were greatly damaged during the Cultural Revolution. A great number of student dormitories were occupied, and classrooms were put to other uses. Student enrollment was much lower than it

had been before the Cultural Revolution. After ten years of chaos, the country attached much importance to the restoration and development of educational facilities. During the seven-year period from 1979 to 1985, the six upper-level institutes under the aviation industry system received a total funding of 102,000,000 yuan for capital construction through various channels; this sum was approximately equal to the total funding for the previous twenty-eight years.

Three important institutions of higher education--Beijing Aviation Institute, Northwest Industrial University, and Nanjing Aviation Institute--established impressive new classroom buildings and libraries and added large amounts of housing for faculty, staff, and the work force, as well as dormitories for the students. The total area of the various kinds of new construction in the six upper-level institutions during the seven-year period was 385,000 square meters. This represents an initial step in improving the educational environment and the living conditions of teachers and students.

The newly-built factories administered by the Nanjing Aviation Institute and the Beijing Aviation Institute are already capable of producing pilotless aircraft and ultra-light aircraft.

3. Efforts to Improve Employee Housing Standards

During the early 1950's, housing for staff and workers was built at the same time that factories were established. At that time, Shanghai-area workers who were engaged by or transferred to the aviation factories of the Northeast were satisfied with their housing there.

Nevertheless, in 1958, after the Great Leap Forward, the long period of "production first, then housing" in capital construction began to create increasing deficiencies with respect to housing. Worker and staff living conditions declined in every respect. According to statistics from the end of 1979, the average living area for all the staff members and workers (as well as dependents) of the aviation industry system was 3.7 square meters per

person. Accommodation was insufficient, and there were sharp conflicts. The staff and workers were not satisfied, and the leadership was worried. It had become a very obvious problem. The housing situation for a few core factories that had been constructed in the Northeast during the first Five-Year Plan was even worse.

During the five years from 1980 to 1984, work proceeded energetically. In all, 2,780,000 square meters of housing were constructed, and more than 400,000,000 yuan were invested. Despite factors such as the increase in the number of personnel leaving or retiring, the increase in the number of workers and staff, and the increase in the population, housing conditions improved year by year. By the end of 1984, the average living area for each worker or staff member and their dependents had risen to 4.4 square meters. Although the housing crisis was somewhat alleviated, it will take a sustained effort over a long period of time to ensure that newlyweds and every family have reasonable apartments.

4. Technological Successes

When the Sibei engine was imported, the British suggested that the equipment and testing system for the engine's test-run platform be supplied by them. The quoted price was very high. After analysis by the Fourth Planning and Design Institute, it was decided that, though the testing precision prescribed for this test-run platform was on an order considerably higher than anything available domestically at that time, we had already accumulated years of experience and could ourselves make the design, while the Shaanxi Engine Factory would be able to do the manufacturing. All that was needed was to import a testing system for research and development use from Great Britain.

After more than two years, the test-run platform designed and manufactured in China was completely installed and debugged. In July 1979, the test-run platform was certified by both China and Great Britain. It was agreed that the platform was of high quality and possessed the advantages of having a compact structure, a wide field of vision, and a precise testing

capability, as well as being easy to operate. It used a horizontal moveable sound muffler, and was able to improve the air intake flow field. It was based on an ingenious conception and was of the most recent design. Only 3,300,000 yuan were spent on its development and manufacture, with equipment accounting for 1,000,000 yuan. This is equal to only a fraction of the cost of importing. The test-run platform was awarded a first-class Aviation Industry Ministry award in 1979 for scientific and technological achievement.

By designing and manufacturing this test-run platform, we not only saved a large sum of money and foreign exchange, but also trained a contingent of workers, promoted our own technology, and bolstered our confidence. The facts show that we need only do a good job of organizing our strengths in order to accomplish things which are equal to the achievements of industrially developed nations. The State Council, in February 1980, indicated in a report to the Aviation Industry Ministry: "We should trust ourselves. We should not improperly belittle ourselves. We need only mobilize the enthusiasm of the masses and take full advantage of the material base built up by thirty years of construction. In this way, we can accomplish many things."

The erection of Chairman Mao's Memorial Hall at the end of 1976 was a special political task. The work of designing the interior chamber and the large-scale, specialized equipment which protects his remains was assigned to the Fourth Planning and Design Institute after a comparison was made among plans offered by several different units from across the nation. This project had no precedent, and there were no materials which could be used for reference. Working in association with the Nonferrous Metallurgical Research Institute and other units, after simulation experimentation, they selected for use a low-temperature air curtain cooled crystal coffin, and a dirt-free clean room in which there were one hundred levels of parallel vertical currents, flowing down from the ceiling. This arrangement satisfied the requirements of stable temperature and a high level of cleanliness. In August 1977, the project operated successfully after a single set of adjustments. During these last few years of operations, the results have been excellent; the project has received a commendation from the National Conference of Science.

There are additional successes: 603 film waterproof material has solved the problem of leaks in the walls of rooms and of seepage in basements. H80 epoxy paint, resistant to acidity and alkalinity, has many uses. Successful solutions were also found in other programs: An exchange device for ions of sodium and hydrogen reclaimed from pressurized countercurrents of water softened for boilers; the model JLB-18 dust filter complex to prevent damage from dust; the small-scale model DJL-II sodium hypochlorite generating installation for potable water; the electrolytic air float method for handling contaminated electroplating water; an energy-saving industrial furnace which itself preheats the burner mouth; the use in circulation of processed fluorescent waste fluid; the model WGS miniature control/telemetric/remote communications/remote control installation for use in a factory's electrical supply system, water supply, air flow regulation system, boiler room, air pressure station and automated production lines; a solution to the problem of studying the prevention of vibration in the upper machine tool floors of a multistory factory; and handling swelling in the subterranean portions of foundations.

5. Reformist Steps

During this period of time, the most profound change was the reform of the economic system. The situation in which enterprises eat from the national pot was gradually broken. Capital construction and technological reform relied more and more on the enterprise's own strength. This mobilized to a great extent the enthusiasm of the basic enterprise units. It also encouraged units to improve business management. During the sixth Five-Year Plan, the Aviation Industry Ministry and subordinate enterprise units have themselves contributed construction funds of 740,000,000 yuan. This was more than 50% higher than what the government budgeted for the period. This funding, targeted specifically for upgrading technology and improving living conditions and facilities for staff and workers, has been of great use.

Under the plan for national development of the construction industry and reform of the capital construction management system, beginning in 1983 the government encouraged the principle of making the construction unit responsible for finding its own capital. By the end of 1985, there were already 52 construction projects which had been implemented under this system; the total amount of investment was 400,000,000 yuan. Because, since the introduction of the "self-responsibility" policy, there was a direct relationship between the work responsibility of workers and staff members and their own profits, the enthusiasm of the masses was mobilized and the feeling of responsibility of cadres at every level was strengthened.

After the implementation of the policy of self-responsibility in investments, many people came forward with solutions to problems; the phenomenon of unrestrained spending began to diminish. According to the statistics for 16 projects in 1984 alone, the total of "self-responsible" investments was 7,870,000 yuan, with a surplus of 1,560,000 yuan as a result of savings. More than 50% of this was given to the government. Thus, there are advantages for the country, the collectives, and individuals.

Initial experimentation with inviting bids for work contracts has demonstrated the advantages of such a system in the case of two projects. The Aviation Institute's runway project was projected to cost 20,600,000 yuan. When several units were asked to work on the initial drafting stages, they were of the opinion that the projections were low by several million yuan. When the bidding on the project was opened up, the Ministry of Transportation's Second Navigational Affairs Bureau won the project with a bid of 14,790,000 yuan, ten million less than the highest bid. The Bureau went to work in earnest; construction quality was good, and was unanimously commended by the interested unit.

The machining of the cooling mechanism for the Xinan Engine Research Institute's high-altitude test-run platform was assigned by a national plan directive in 1983 to a specific factory. This factory estimated the cost would be 42,000,000 yuan, 16,000,000 yuan higher than the budgetary estimate;

the time requirement was estimated at 46 months, which represented a considerable delay to the original plan. Afterwards, in the spirit of reform, a number of units with machining capabilities were encouraged to submit tenders; the Sichuan General Construction Company and the Lanzhou Petroleum/Chemical Engineering Machinery Factory won the bidding with a joint estimate of 22,900,000 yuan, 3,100,000 yuan below the budgeted estimate, and with a time estimate shortened by over two years.

The reform of the capital construction system was aimed at the undesirable practice of using capital construction funds without repayment, or "eating from the common rice-bowl"; it has already achieved a measure of success. Nevertheless, because it is only just beginning, there are many new problems. For instance, using the "self-responsibility" system of funding, how can a base figure for the responsibility be accurately determined? How can differences in the bonuses for capital construction workers and staff and other workers and staff be handled? During the process of inviting and submitting bids, several regions and departments have implemented monopolistic protection policies in disguise, so that true, fair competition is still impossible. Several other items of reform have their own problems. All these problems remain to be rationalized and resolved gradually in actual practice, which will further perfect and complete the system reformation.

TRAINING AND DEVELOPMENT OF THE CAPITAL CONSTRUCTION CONTINGENT

The aviation industry's capital construction forces, after 35 years of practical training, have acquired solid capabilities in areas such as preliminary investigation, planning, installation, and contracting. For the 1980's and later, the aviation industry's construction has been turning to a policy of emphasizing technological improvements; the scope of capital construction has contracted by comparison, and there is available a supply of surplus capabilities that can be placed in the service of other departments.

The Fourth Planning and Design Institute, from its founding in 1951 as an aviation industry design organ, gradually expanded to a staff of 1,560 in

1956; despite subsequent fluctuations, the total has generally been maintained at this level.

In the early 1950's, the number of Soviet experts at the Fourth Planning and Design Institute reached its maximum of 49 persons. The Soviets took responsibility for the design activities, and we Chinese cooperated with them. In 1958 the Soviet experts were reorganized on a consulting basis, and we began to do the designing ourselves. At the beginning of 1960, the Soviets withdrew all their experts, and we took over all phases of the designing operation.

The Fourth Planning and Design Institute not only has a complete line of specialties in industries like technology, civil engineering, power, and non-military construction, but at the end of the 1950's it also built up a strong equipment design team, which designed complex equipment such as an engine test-run platform, a wind tunnel, and a variety of experimentation installations and industrial furnaces. This team was a dynamic force in the technological improvements at that time.

After the Fourth Planning and Design Institute was formed, in addition to designing factories, research organizations, and other projects for the aviation industry system, it also bore a share of the projects of the Air Force, Navy, and Civilian Aviation, especially repair installations for airplanes and engines. Beginning in the early 1960's, it also assumed the design responsibilities for programs related to countries such as Albania, Vietnam, Tanzania, North Korea, Pakistan, Romania, Egypt, and Jordan.

In 1979, after the Fourth Planning and Design Institute was approved as the planning and designing unit for the first set of fee-collection points to be run experimentally as businesses (meaning that they would no longer accept the national operating expenses but rather "rely upon themselves for support"), the system of technological and economic responsibility was implemented. In addition to guaranteeing the capital construction design responsibility for their own department, they also actively turned a face

toward society and began opening up new areas of service, such as transfer of technology obtained from scientific research. Their work became more prosperous with each passing day. The amount of work completed in 1985 was four times the total for 1978; of this, over one third was for other industries.

In this period, in the area of civil construction, the 43-story Shenzhen Zhong Hang Building was designed. In the area of service for other industries, assistance was provided for the Tianjin Bicycle Factory in undertaking the work of technological improvement design, which increased the plant's capacity of Fei Ge brand bicycles from 2,000,000 to 3,500,000. The Heilongjiang Food Products Company's comprehensive soybean processing plant has a production line, imported as a unit from West Germany and capable of processing 100,000 tons of soybeans yearly; the general design, construction work, and power system for the line were designed by the Fourth Planning and Design Institute. There have also been a cotton mill, a pharmaceuticals factory, and many other projects.

The Fourth Planning and Design Institute also set up a developmental advisory department to develop practical research and consult about work, as well as to open up channels for cooperative design projects with foreign concerns. In response to requests from Hong Kong's Huarun Company and Macao's Nanguang Company, the Fourth Planning and Design Institute sent some ten representatives to undertake design and supervise construction.

The Third Design Institute, organized at the end of the 1970's, includes a staff of 300. It provides supplemental capabilities for plant design for the aviation industry. Its main responsibility is the task of designing for the southern region.

The Aviation Industry Ministry's general survey office is an expansion and reorganization of the Second Machine Industry Ministry's survey office, established in 1952. It has a staff and work force of over 600, and capabilities in hydrogeology, engineering geology, surveying and engineering

pile driving, etc. In the 1980's it also developed capabilities in physical and chemical flushing of water wells, measuring dynamic and static loads, and environmental protection monitoring. The Institute has regularly had the responsibility of all surveying for aviation industry construction. Its workers range throughout the entire country and have left their mark everywhere. They have searched for water sources in the yellow earth regions, the karst regions, and other regions with hydrogeologically complex conditions. They have experience in problems with soil in regions with pits subject to collapse, expanding soil, sliding slopes, landslides and soft foundation soil. The institute has become a unit possessing comprehensive surveying capabilities.

The Xibei Installation Company has a staff and work force of over 1,000, and has taken responsibility for installation of many items of heavy, large-scale equipment for the aviation industry. It has a technologically well-trained work force.

Establishing engineering contracting companies is a management organizational reform, part of the country's change to an administrative method in organizing construction work. The aviation industry system established the Chinese Aviation Engineering Contracting Development Company in 1985 and four other engineering contract companies. Beijing's Chinese Aviation Engineering Contracting Development Company, backed by the Fourth Planning and Design Institute, is able to take over the work of feasibility studies for construction projects, survey planning, equipment pricing and purchasing, ordering material, carrying out projects all the way to completion and the beginning of production; it can also join in shared contracts, as well as serve as general contractor for entire processes. The company has also vigorously developed horizontal coalitions, and developed and promoted new types of construction materials.

International contracting work began to develop quite early. The Chinese Aviation Technology Import and Export Company began a contract project in Jordan in 1980, and later contracted for work in Kuwait an the United Arab

Emirates. By 1985, the total value of contract projects had reached $150,000,000 (U.S. dollars), and 600,000 square meters had been constructed. Over 7,500 man/trips had been organized out of the country to supply all varieties of labor and service. Several residential projects have already been completed in the Jordanian regions of Abulusa, Ma'an, and Hasangkuang; these have provided much experience in managing contract projects abroad.

In general, the aviation industry's capital construction contingent is a unit possessing excellent political quality, rich practical experience, innovative capabilities for tackling key problems, and a spirit of struggle against adversities. It shows perfect mastery in shouldering and adapting itself to a great variety of tasks.

Looking at the experience of the last thirty and more years, the construction and development of our aviation industry have passed through a broadening, strengthening process. Although there have been a number of complications, in the end very great difficulties have been overcome. We have passed from a "have not" to a "have" condition, from small to large, from a transitional stage of overhauling to production, from copying to designing. In the work of capital construction, from the lessons of positive and negative experiences, a variety of methods appropriate to the Chinese situation was gradually forged out, and the following important results were achieved:

1) A relatively complete system of research, production and education covering virtually all airplane categories, including fighters, attack planes, medium-size bombers, transports, helicopters, training planes, and civilian passenger planes, along with their engines and accessories, has been established.

2) There is a reasonable overall arrangement in the aviation industry. Aviation industry factories and research organizations are spread over twenty provinces and cities. Since the policy of encouraging construction in the Chinese interior was implemented in 1964, newly built "third-line" factories

and research institutes have been set up in our strategic depth, in keeping with strategic requirements.

3) A contingent for surveying and designing, capable of its own independent work, has been trained. The Fourth Planning and Design Institute the Third Design Institute, and the Comprehensive Survey Institute have been founded, with a total of 2,500 workers and staff; they are capable of surveying and designing aviation industry factories and research organizations unaided, and are also able to contract work for many industries and carry out the design work for civilian architecture.

4) The level of technology and engineering has been steadily raised. There have been breakthroughs in many new technologies, making contributions in the economic use steel materials, reducing construction costs, filling in technological gaps, and the promotion of production and research.

After thirty-five years of construction, the aviation industry has become one of our country's newly flourishing production industries, and is a dynamic driving force in our new technological revolution.

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赵紫阳总理视察江南无线电器材厂

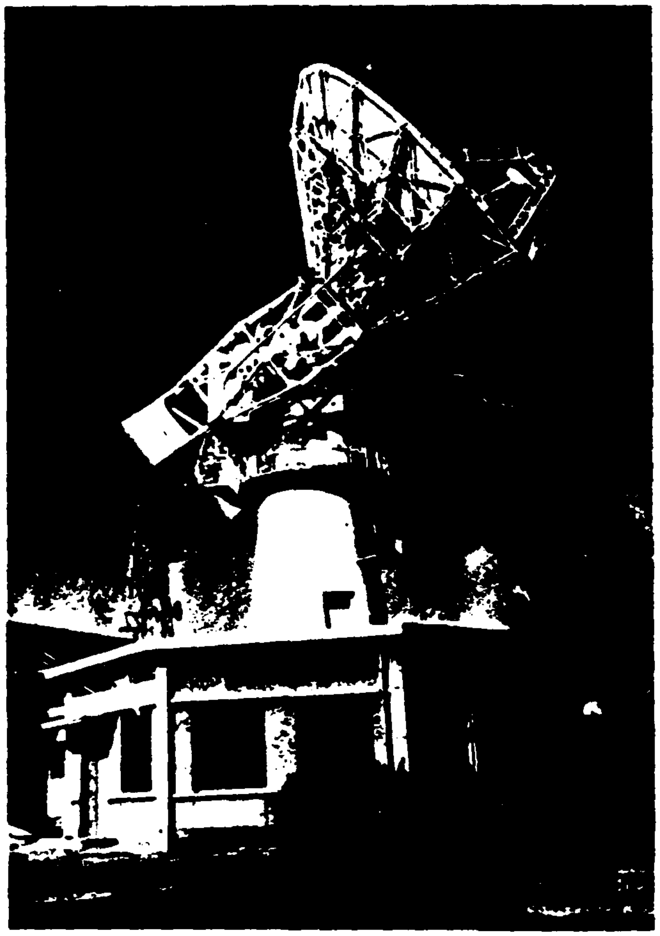
Premier Zhao Ziyang inspects
Jiangnan radio equipment factory

江南无线电器材厂集成电路生产线

Jiangnan radio equipment factory integrated circuit production line

陕西彩色显象管总厂厂区全景

Overall view of color picture tube factory



卫星地面站

Satellite ground station

上海电视机一厂装配线

Assembly line at Shanghai Radio Factory 1

深圳爱华电子公司微电脑装配线

Shenzhen Aihua Electronics
Company microcomputer assembly line

深圳爱华电子公司微电脑终端生产线

Shenzhen Aihua Electronics Company
microcomputer terminal production line

长沙韶光电光厂络板生产线清洗间

Changsha Shaoguang Electro-optical Factory complex board production line washing room

杭州电子工业学院教学大楼

A lecture hall at Hangzhou Electronics Industry Institute

华南计算机公司计算中心

Computer center at Huanan Computer Company

TECHNOLOGICAL TRANSFORMATIONS ON AN ADJUSTED FOUNDATION [PAGE 98]

After the third plenary session of the eleventh central committee of the Chinese Communist Party, capital construction for the electronics industry underwent vigorous adjustment and development under the correct guidance of the Party central committee. During the six years period covering 1979 to 1984, the Electronics Industry Ministry's investments for capital construction projects amounted to 37.9% of its total completed investments of the 35 years since 1949, 21.8% of the total completed floor space, and 41.1% of the fixed assets; more new electronics industry fixed assets were added during this period than during any other period. The most important aspect of electronics industry capital construction during this period is that it aggressively and effectively made adjustments and corrected the problems of the preceding period, including the scope of its undertakings, the number of redundant constructions, and the imbalance in the relationship between "bone" and "meat." At the same time there were plans to transform the industry's technology step by step. The chief measures for the adjustment were:

1) To put in order projects under construction, condense the scale of construction, reduce the scope of capital construction. During the three-year period from 1979 to 1982, 33 projects were abandoned or postponed, of which 13 were large-scale or medium-scale projects and 20, including twelve single-item projects, were small-scale undertakings. A decisive program of adjustment and retrenchment effected a basic change in the severe internal proportional imbalance. A policy of ensuring high-priority undertakings was implemented as part of the adjustment. Investment during this period was directed chiefly to three areas: 1) 66.4% of the total went to the priority imported technologies and technological transformation, especially in the areas of color television, integrated circuitry, chromium plating, coolants, and computers, as well as other high-priority areas of this kind. 2) 18.6% was used for the construction of dormitories and facilities for the staff and work force. 3) 11% was used for the improvement, maintenance, and construction of schools and laboratories. With these measures, the scope of undertakings was effectively reduced while priorities were safeguarded. The rate of

construction was improved, with large and medium-scale projects placed in operation within a time-frame of two or three years; the construction cycle returned to the level enjoyed during the first Five-Year Plan.

2) To adjust "third-line" construction projects. Under a unified national plan of deployment, planned, measured adjustments were undertaken on "third-line" enterprises on the basis the their condition. For key enterprises with a strong technological capacity and good conditions of production, a policy of "accentuating the positive" was followed. Their tasks were set in order, and their hidden strengths were developed, so that their full potential could be brought into play. In the case of redundant construction, or factories which had good long-term prospects for development, although their production assignments were currently insufficient and the productive capacity was greater than actual need, their status was raised by adjusting the direction of production or by consolidation and reorganization. Seriously redundant projects under construction, or research factories or laboratories which had been completed in an inappropriate location and whose productivity was difficult to maintain, or factories with inferior conditions of production (including low product quality, heavy consumption, high costs, or redundancy within their province, municipality, or autonomous region) were handled differently: As conditions warranted, the scale of construction was reduced, or the installation was closed permanently or temporarily, combined with another installation, converted, or moved. For example, the Xinan Machinery Factory was merged with the Changzheng Machinery Factory; the Tongchuan Transistor Factory was merged with the Huaxing Radio Equipment and Materials Factory; the Fenglei Equipment and Materials Factory was moved to Mianyang City; the Yinchuan Semiconductor Factory was relocated; the Baoji Transformer Works was converted into a school; some of the laboratories were merged, some were moved to a new location.

3) To improve living installations. Since 1979, construction of dormitories for staff and work force increased year by year, and living conditions underwent continuous improvement. Statistics indicate that in the thirty years before 1979, construction in terms of floor space of dormitories

and installations for staff and work force represented only 41.3% of the total construction of that period, while after 1979 the figure rose to 61.7%.

4) To increase the construction of schools, institutes and laboratories. From 1979 to 1984 the national government invested 85,000,000 yuan in the construction of schools and institutes for the electronics industry, 6,000,000 yuan more than the total of the preceding 30 years. Because of the increase in this kind of investment, the educational undertaking for the electronics industry recovered and developed very quickly. By the end of 1984, there was a total of 19 educational establishments, of which six were at the university level, ten were at the high-school vocational level, and three were technical schools. In the past few years, factories have raised funds and initiated education centers and schools of all kinds. They have had great success, and the electronics educational undertaking has been thriving and expanding.

Electronics industry laboratories have undertaken corresponding construction and improvement. In the six-year period beginning in 1979, China invested 194,000,000 yuan for transforming, constructing and expanding the enterprise of electronics research, 8,000,000 yuan more than the total for the preceding 30 years. After several years of transformation and construction, the electronics research enterprise has shown great development.

China's electronics industry, although after thirty years of development between the founding of the new China until 1979 it had a considerable material and technological base, nevertheless still had many old undertakings with equipment that had yet to be modernized. The productivity and technology of these undertakings were backward, their product line showed no variety, their quality was not stable, and they were unable to fill the requirements of construction for the Four Modernizations. Since 1979, the decision has been made to place the emphasis in investment on the technological build-up of existing enterprises. In the thirty years before 1979, investment in new projects represented 71.7% of the total investment of that period; investment in rebuilding and expansion represented 28.3%. In the six years since 1979, thanks to adjustment in the direction of investment, only 45.8% of total

investments for the period was used for new construction projects, while 54.2% was used for rebuilding and expansion. In the area of technological improvement, emphasis again was on importing technologies. There were fifteen key importation and modification projects to accelerate the development of electronic computers and software, and 30 key factories and laboratories were imported and modified to improve the quality of components and accessories and to broaden the product line. To improve the quality of electronic consumer products and expand the product line, over the last three years of the Sixth Five-Year Plan, 144 work units made it their priority to import 167 modification projects. Seventy-one of the units and 88 of the projects were under the Ministry; and 73 of the units and 79 of the projects were connected with local industry.

For importing technology and undertaking technological modifications, there are three main methods, all producing good results:

The first method is to import equipment and technology in complete sets. Examples of this method are the Shaanxi Comprehensive Color Kinescope Factory, the Wuxi Jiangnan Radio Equipment Factory's linear integrated circuit production line, the Huadong Electronic Tube Factory's coolant production line, the Shaoguang Electrical Appliance Factory's chromium plate production line, the Hunan Jiannan Machinery Factory's magnetic recording equipment, the Huanan Computer Company's Suo La Computer production line and the production line for color television accessories. These technological imports have strengthened the technological and economic foundation of China's television, computer, and integrated circuit industry, and have enabled our electronics industry in several fields to attain the international levels of the end of the 1970's and the beginning of the 1980's. The contract for the Shaanxi Comprehensive Color Kinescope Factory import project, for example, was signed in 1978 and work began in April of the following year: Large in physical area, this important project included the installation of electromechanical, chemical, gas, and power equipment; it demanded high-quality, spotlessly clean construction, used difficult, complicated technology, and had a short construction cycle. With the hard work of the whole construction unit staff

and work force in surveying, planning, construction and installation, the project was completed and began production after an interval of barely two and a half years. 730,000,000 yuan were invested in the capital construction, and the total area of the structures came to 380,000 square meters, of which 190,000 square meters were for production (including 20,000 square meters of clean workshop area). In October 1981, the initial trial batch of acceptable "Rainbow" color kinescopes was produced, marking the end of our reliance on imports in this area. The quality of this project is excellent; it won the 1985 National Top-Quality Project silver medal. In 1983, 580,000 color kinescopes were produced, and 35,800,000 yuan in profits tax were realized. In 1984, production reached its planned capacity of 960,000 kinescopes, and 120,000,000 yuan in profits tax were collected. Product quality was good, winning the national gold medal. Demand for the product within China was high, and there was a small amount of exports. Along with other import projects, an annual production capacity of nearly one million color television sets was achieved.

The linear integrated circuit television accessory production line construction project, imported by the Wuxi Jiangnan Radio Equipment Factory, is another example. For a total investment of 276,600,000, 97,554 square meters of floor space were constructed, of which 45,314 square meters were factory. Construction was begun in May 1980, and thanks to the industry of the construction workers, the rear process production line was completed, inspected, approved, and placed in operation by October 1982. The front process production line was ready over its entire length in June 1985, successfully underwent government inspection and went into production. The planned annual production capacity of 26,480,000 linear integrated circuits was achieved, enough for installation in seven to eight million color and black-and-white televisions. This project was named "Superior Building Complex" among local projects by the Jiangsu Province Construction Committee; the satisfactory rating of the installation project reached 98%, and attracted favorable comment both at home and abroad.

The Hunan Jiannan Machinery Factory imported equipment and technology for the production of magnetic recording devices in order to develop computer peripheral equipment and to provide the technological conditions for production. The Factory's production line importation project was of high quality, and won the National Top-Quality Project silver medal in 1985.

These importation projects featured not only speedy construction, high-quality engineering, economical investment, and good benefits, but also relatively advanced technology and high production capacity, and laid a very good foundation for the development of China's microelectronics industry.

The second method is to import key equipment and technology, and to undertake modifications. Examples include the Jilin Dongguang Radio Equipment Factory, which after technological cooperation with foreign interests imported front processing manufacturing technology for aluminum electrolysis capacitors and key equipment for high voltage capacitors. After the imported technology was studied for over a year, equipment was built locally and installed. The production line's yearly production of 90 tons of aluminum foil, 10,000,000 small high-voltage electrolytic capacitors, and 30,000,000 large electrolytic capacitors was easily achieved; product quality was up to the currently prevailing international standards. At the same time, in cooperation with fraternal factories, some of the imported equipment was improved, and the small electrolytic capacitor production line was modified; yearly production was raised from 3,000,000 units for the first year to 50,000,000 units. Economic benefits increased every year, and the total value of the products rose from 1,500,000 yuan in 1982 to 4,000,000 in 1984. The Gansu Tianguang Electronics Factory, using key imported equipment, set up a front processing line for the manufacture of integrated circuits with a 75-millimeter silicon board, and reached a monthly production capacity of 1,000,000 circuit cores; worker productivity was raised an average of thirty-fold, and the product technical target reached the international standard for products of the same class. The Factory received a National Economics Committee award for all-around excellence for importing and improving technology. The Hubei Changjiang Telegraph Factory imported key equipment and technology for a

production line to assemble series T1000 teleprinter; after technological modification, it now has a yearly production capacity of 4000 teleprinters and 200 telefax machines, double the original production capacity. The DCY model teleprinter is regarded as a quality product at the Ministry and the provincial levels, and its economic benefit has been greatly enhanced. The Nanjing Telegraph Factory imported key equipment and technology to manufacture double-sided and multilayer print plate makers and LX-213 needle-style mimeographs. After three years of rebuilding and technological modification, they have been able to industrialize the conditions of production. Product quality is good, abd China's computerized production and assembly capacity and technological level have been improved. The project has exerted an active influence on the development of new products.

The third method is to import, analyze, and imitate samples, and then implement technological modifications. For example, the Nanjing Radio Factory at the time of liberation was a small plant with less than a hundred staff and workers, extremely simple in every respect. In the last 35 years, thanks to many technological modifications, it has developed into a modern, large-scale electronics enterprise with a staff and work force of several thousand. Since 1979, in particular, the method of importing, analyzing, and imitating samples has been used to improve and construct many production lines; integrated color televisions, the technology for constructing earth stations for satellite communications, the importation of technology for automatic dialling radio systems, with technological modifications, have all been effective, and production and the development of new products have continuously been in the front ranks of the electronics industry.

Another example is the Sichuan Hongguang Electronic Tube Factory's black-and-white kinescope assembly and production line. Under the historical conditions at that time, with great self-reliance and determined efforts, when internally China possessed no mature technologies and no resources of technological information, they courageously used new technology and methods. With the supporting efforts of related factories, they made modifications over the course of ten years, and studied all semiautomated production lines that

exhibited China's own technical strong points. In 1983 they began production. When production experience was acquired, the operation was basically successful. The original planned annual capacity was 500,000 14-inch and 17-inch black-and-white sets. In 1983, production was nearly 320,000 sets, and in the following year it reached 420,000 sets, with a value of nearly 40,000,000 yuan; 4,000,000 yuan of the total was profit. The annual capacity of this production line, after small improvements, may reach 850,000 sets, and a great improvement in product value and profit may be anticipated.

As the capital construction of the electronics industry has developed, planning for the specialized electronics industry, including equipment, installation, and capacity, has also increased without interruption.

Currently, the Electronics Industry Ministry has under it the Tenth and Eleventh Design Research Institutes and the Shenzhen Branch Design Institute, as well as two design offices at the bureau level. The Tenth Design Research Institute's earliest previous incarnation was the design office of the Heavy Industry Ministry's Telecommunications Bureau founded in 1953 in Beijing. The Eleventh Design Research Institute was organized in the city of Jinzhou in August 1964; in 1966 it was moved to the city of Mianyang. These design units currently have over 1,700 workers and staff, of which over 60% are technical personnel. They have in succession established automated inspection, electromagnetic protection, chemical technology, anti-vibration, purification technology and other experimental laboratories and experimental factories, as well as a small-scale computer station. Over the years they have completed designs for nearly a thousand projects (including 19 foreign aid projects). Incomplete statistics indicate that over 400 technical summaries and dissertations have been written on design and research, nearly 2,000 volumes of standard design plans have been compiled, and over 80 design manuals of all kinds have been written. Over 100 major innovative technological research programs have been completed, including electromagnetic wave extension and cover, anti-vibration measures for multistory factories, and many model programs for controlling cutting machines. The National Science Convention award was presented for its achievement. The Shaanxi General Color Kinescope

Factory, the Jiangnan Radio Equipment Factory linear integrated circuit production line, the Microwave Darkroom 1029 and other design projects won the National Excellence in Design Award. The design institutes have developed into a comprehensive design study organization with a complete range of specialties and strong technological capabilities.

The earliest predecessor of the Comprehensive Survey Institute of the Electronics Industry Ministry was the First Machine Industry Ministry's General Design Bureau's Northwest Survey Brigade, founded in March 1953 in Xian. It now has over 600 workers and staff, 21% of which is technical personnel. Its most important responsibilities are engineering surveying, engineering geology, hydrogeology, engineering materials evaluation, environmental monitoring, foundation piling, and similar engineering tasks. Over the years it has completed over 1700 surveying projects, including over 20 abroad. It has written over 140 dissertations and monographs. It has collaborated with related units on the "Engineering Geology Handbook," for which it won a National Science Convention award. The model DCH-500 range finder, developed in cooperation with Qinghua University and other units, won a third-class award for research from the National Defense Science Committee. The Institute has developed into a general surveying organization with strong capabilities and a high technological level. It is not only able to undertake the surveying for medium and large engineering projects, but it can handle the surveying responsibilities for complicated, specialized projects as well.

The Electronics Industry Ministry's Electromechanical Equipment Installation Company was formerly the First Machine Industry Ministry's First Installation Company's Third Engineering Office. It was organized in spring 1959 in Chengdu; in 1975 it was moved to the city of Shijiazhuang. It has engineering offices in Chengdu, Xingping (Shaanxi Province), and Wuxi (Jiangsu Province), and a processing plant in Shijiazhuang. The company currently has a staff and work force of 1,700, of which over 10% are engineering and technical personnel. For over twenty years, it has completed all types of power plants, gaseous product stations, electric distribution/transformer substations, satellite ground stations, microwave communications experimental

projects, large-scale spheres, glass furnace installation, and over 200 brick construction projects, and three foreign aid projects. The company has developed into a solid installation concern, able not only to take on projects involving ordinary electromechanical equipment installation, but also installations with special requirements for purity, cleanliness, or accuracy.

CONSTRUCTION OF THE LOCAL ELECTRONICS INDUSTRY

The local electronics industry is an important component in the national electronics industry, a "regional army," as it were, in our battle for electronics production. The local electronics industry has developed and strengthened step by step with a build-up of the national industry, growing from modest beginnings, with periods of adjustment and several upsurges. At the end of 1984, there were 2,300 businesses and enterprises, including over 2,200 factories and more than 60 research laboratories. There were 930,000 workers and staff members, and over 340,000 instruments and pieces of equipment. The product line included ten or twenty categories and nearly a thousand items and several thousand models of electronics devices and components. The value of yearly production represented 78.7% of the electronics industry production of the entire country. The city of Shanghai and the provinces of Jiangsu and Guangdong ranked first, second and third among China's municipalities, provinces and autonomous regions in the value of their electronics production. In many municipalities, provinces and autonomous regions, the electronics industry figured very importantly in the local economic structure. Construction for the local electronics industry made an important contribution to the development of China's electronics industry and to China's civilian economic growth as a whole.

In the last 35 years, in order to build up the local electronics industry, the national government has invested 1,340,000,000 yuan. Local governments also invested a great deal of funds, using aggressive and effective methods like pooling of resources and shifting production in order to foster the development of the electronics industry. The local electronics industry can now produce a variety of components, radios, computers,

televisions, recording machines, radio measurement instruments, special equipment and radar, and wireless and wired communications equipment; it has also provided a portion of the electronics equipment for advanced scientific projects like satellite launching and guided missiles, making active contributions to these efforts.

The local electronics industry has passed through three major phases:

The first great period of development was from 1958 to 1960. During the initial period of national development and the beginning of the first Five-Year Plan, the country was in the process of implementing economic recovery and building up key industries, and was not yet able to give great attention to the development of the local electronics industry. In April 1956, after Chairman Mao Zedong's "Discussion of Ten Great Relations" was published, the policy of advancing centralized and local industry together was implemented for the electronics industry, and local electronics industry construction gradually developed. In 1958, the Communist Party central committee, meeting in Chengdu, proposed to "root out superstition, liberate thought," and set into motion a large-scale national promotion of the electronics industry. In Shanghai, Jiangsu, Liaoning, Beijing, Tianjin, Guangdong, Wuhan, Shenyang, and other places many means were used, such as shifting production of light industries like textiles and machinery, in order to achieve significant development in the electronics industry. In the space of a few years, over 2,000 plant sites were developed. These plants were all rather small in scale and the technical capabilities were weak; factory equipment was primitive. To enable these plants to develop their functions quickly, local governments implemented the work of merging factories on specific sites. By April 1961, based on calculations after the merging had been undertaken, the local electronics industry had a total of 259 relatively sizeable factories.

At this time, the country's investment was concentrated on key construction projects. The method of "select the strongest seedlings" was applied to the local electronics industry; if, from the angle of investment and products, a plant was considered "key," it was given additional support.

Based on incomplete statistics, at the end of 1960 the national investment in capital construction for the local electronics industry was 45,650,000 yuan, most of which was used in 1959 and 1960. At the same time, the localities also produced a certain amount of funds to support their factories' capital construction.

In order to solve the problem of cooperation among enterprises in the distribution of specialized work and cooperation among enterprises in the local electronics industry, from 1963 to 1965 the Fourth Machine Ministry along with the National Planning Committee and local governments, based on the principle of the whole country as a game of chess, implemented overall plans and adjustments for the electronics industry in East China, the Northeast, and North China. In this period, over 34,000,000 yuan were invested for local electronics industry capital construction. After about three years of planned step-wise adjustments, a foundation for a rationally arranged, comprehensive overall layout was achieved.

The second great period of development in the local electronics industry was from 1969 to 1971. This period was mainly one of construction coordinated with small local military projects distributed over small towns in the mountainous or rear regions of the provinces and autonomous regions. During the period, the amount the national government invested in local electronics industry capital construction represented 39.5% of the total investment in the electronics industry; in 1971, the amount of the government's investment reached 200,000,000 yuan. In this period, following the motto "plan big for military projects," in the 22 provinces, municipalities and autonomous regions throughout the country, there was a widespread attempt to get on board. There was a total of 71 projects begun, and 59 completed, including 19 factories for completed products and 38 for components, as well as two special equipment factories. There were many problems during construction. Not a few factory layouts were excessively spread out, or inappropriate sites had been selected. Construction was carried out unthinkingly, or was redundant. After completion, the mission of some factories turned out to be insubstantial, or

it became apparent that there was no mission at all, or the intended purpose was difficult to achieve.

After these two phases of large-scale development, on the basis of statistics after the 1972 adjustment, there were over 2,000 factory sites for the local electronics industry throughout the country. Every province, municipality and autonomous region, including Tibet, had an electronics industry.

The third period of development proceeded steadily on the foundation that had been consolidated during the period of adjustment. After 1979, in step with the civilian economy and the rise in the people's level of material culture, the demand for electronics products rose day by day, driving the rapid development of the local electronics industry. The local electronics industry, advancing during the period of adjustment and reform, was characterized by the speed of production shifts, the speed of its technological improvements, and its economic strength. Local governments chiefly employed three vigorous, forceful measures in the development of the local electronics industry:

1) Adjust and move enterprises in problematic locations to improve their conditions of production. A number of provinces, municipalities and autonomous regions moved third-line enterprises in mountain districts to small or mid-sized cities. For example, Guangdong Province moved several factories from the mountain regions in the north of the province to coastal cities and imported technology to undertake construction. These factories have developed into eight electronics companies like the Huaqiang, Huaxing, and Lingnan companies, which technologically represent great improvements, and economically are several times more profitable. The small third-line factories of Fujian Province also established branch factories or product research laboratories in the coastal region to advance the development of production. Inland provinces' small third-line factories in some cases were merged with urban factories or were jointly operated, improving the conditions of business and production.

2) Provide support in the area of policy. Incentives like tax reduction and immunity were offered by way of encouragement and support to improve conditions in the area of construction materials and technological changes, and to ensure unimpeded development of the enterprises. At the same time, a corresponding group of electronics research laboratories was built to strengthen research and development capabilities. The enterprises themselves, which had been using obsolescent plants and local materials and technology, eagerly set about technological reform. They worked rapidly and early obtained results; after several years of rebuilding, they had a whole new look. For example, the Wuxi Television Factory, under the national policy of support and by its own efforts, implemented technological renovation and development. This factory was the result of a decision in 1972 to merge two small neighborhood factories and change their products. In its initial period it produced experimentally 14-inch televisions and 2.5 inch black and white projection televisions. The factory itself was simple, and the equipment was seriously deficient; there were no technical specialists, and as the quality of the product was not high there was no market for it. The enterprise operated at a loss for several years running. In the six years since 1979, encouraged by higher levels of government and with the determination for struggle of its work force and staff, by means of thrifty and industrious management, it has regenerated itself by its own efforts; over time it has introduced production lines, key production equipment and a quality control system. It has expanded its facilities and improved conditions of production. After several years' efforts, by the end of 1984, it was able to produce 14-inch and 17-inch black and white televisions, 14-inch and 18-inch color televisions, and 60-inch projection televisions, with an annual total production for all lines of 600,000 sets. During these six years, the annual average production increased 44.8%, the average yearly production value rose 45.7%, and the average yearly profit rose 84.5%. In 1984, the enterprise was cited by the Electronics Industry Ministry as a leading unit in terms of economic profitability.

3) Encourage the combination of enterprises, import advanced technology, raise the level of specialization. For example the city of Dandong merged over thirty electronics factories into just over twenty, of which more than ten were combined to produce high-frequency heads; some obsolescent products were eliminated, forces were concentrated to develop new products, effort was expended on specializing production, productivity increased, quality improved, and profitability was raised to 38,000,000 yuan in 1984. The city of Dalian imported small electrical motors, bearings, magnetic heads as key components of recording devices and organized specialized production; the rate of acceptability of the product increased from an original 50% to 99%.

In order to develop the production of the television industry, a group of advanced projects was introduced under a unified national plan: Beginning in 1983, 17 production lines for color television accessories were imported, or which seven were under the Ministry, and ten had local connections. Of these, six were large and middle-scale projects: The magnetic core production line of the Jinning Radio Equipment Factory, the charcoal membrane potentiometer production line of the Hongming Radio Equipment Factory, the field effect tube and the low-frequency high-power tube production lines of the Beijing Electronic Tube Factory, the high-pressure silicon stack and diode completion production lines of the Tianjin Third Semiconductor Factory, the variable capacity diode and frequency channel switch tube production lines in the Tianjin Fourth Semiconductor Factory. For the above six projects, 5,020 square meters of new factory floor space was constructed, and 14,600 square meters of floor space was rebuilt. There were 11 small-scale projects: The Shaanxi Jinshan Radio Equipment Factory's deflection magnetic cores, the Dongguang and Nantong Radio Equipment Factories' aluminum electrolytic capacitors, the Dandong Radio Factory No. 1's high-frequency low-noise tube, the Jiamusi Radio Factory's loudspeaker components, the Nanjing Electrical Acoustics Equipment Factory's loudspeakers, the Jinghua Radio Equipment Factory's surface wave and ceramic wave filter equipment. Shanghai also introduced a series of accessory technologies related to color televisions. The importation or construction of 17 production lines has completed China's color television capabilities.

In the last two years, all localities have concentrated on the production of home-use electronics items like computers, color television sets, and recording devices. By many means, such as importing advanced technology and cooperating with foreign capital, a great number of medium and small production lines have been introduced; Guangdong Province has imported over 150 lines, Fujian Province over 90. In special economic districts and coastal cities, the local electronics industry's development has been especially rapid. The rise of the electronics industry in Shenzhen, Zhuhai, Xiamen, Fuzhou, Changzhou, Foshan, Wuxi, Suzhou, Nantong, Zhanjiang, Shantou, Qingdao, Dalian and other localities meant that the electronics industry was no longer mainly concentrated in large cities and in the interior. The development of the Shenzhen electronics industry was quite rapid. In 1978, there was only one small factory with a hundred or so workers and staff, and an annual output of 1,000,000 yuan. By 1979, with the creation of the special zone, the electronics industry had already become the largest production industry of the entire city. By 1984, there were 139 electronics factories producing over a hundred products like televisions, recording devices, computers, program control switchboards, civilian broadcasting stations, and facsimile machines, with an annual value reaching 810,000,000 yuan, or 51% of the total industrial output of the city for that year, and providing tax revenues of 78,700,000 yuan. Foreign remittances were 23,410,000 yuan. In the economic structure of the city, the electronics industry held the premier position.

During this period, inland provinces and municipalities also introduced a quantity of imported technology. For example, in places like Yichang, Shashi, Shijiazhuang and Chengdu, the local electronics industry also experienced a rapid technological advance and development.

The masses of workers and staff of the local electronics industry, under the leadership of every level of government, passed through several decades of struggle to establish the industry; they overcame many difficulties, and relying on upper-level support and their own efforts and labor promoted both production and research. They gathered much valuable experience through their

bitter struggles, their industrious and thrifty management, and their emphasis on economic profitability.

In the last 35 years the masses of workers and staff in capital construction for in China's electronics industry, with the guidance and solicitude of the Party and the government, as well as the concerted support and assistance of all the races of China and the related ministries, have written a glorious chapter with their hard work and sweat. Even when they met serious difficulties, or when there were false steps or setbacks, our undertaking nevertheless continued its uninterrupted advance, its great uninterrupted series of achievements.

The strategic mission of development of the electronics industry for the future will be to concentrate our major forces and develop the micro-electronics industry, especially in large-scale integrated circuits and microcomputers, and to lay the material foundation for the speediest possible development of this industry, in order to accelerate the development of military electronic equipment, electronic computers, communications equipment, and other kinds of key products. Consequently the shift in the direction of making micro-electronics technology the foundation will be sped up, and the consolidation, coordination, and development of the electronics industry on a new technological foundation will be realized.

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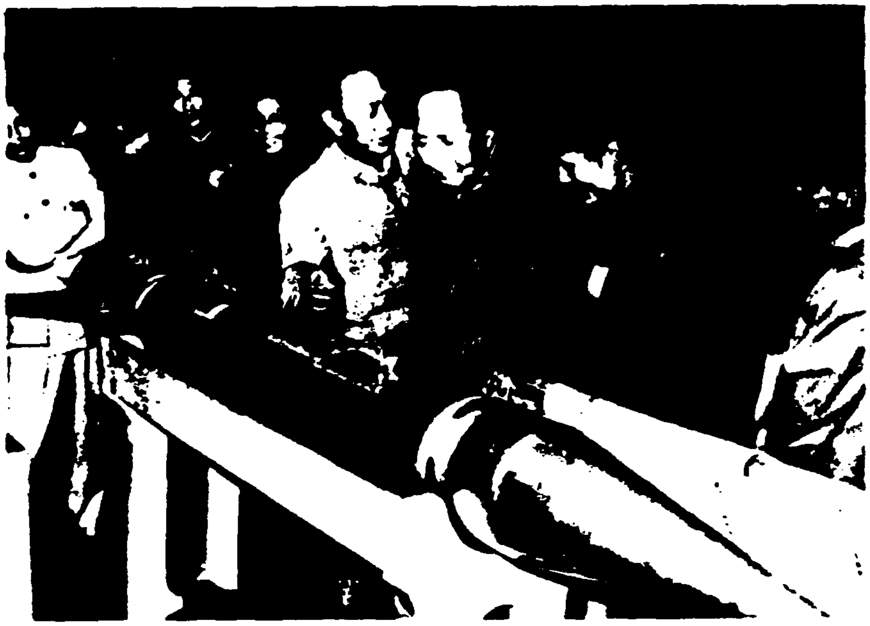
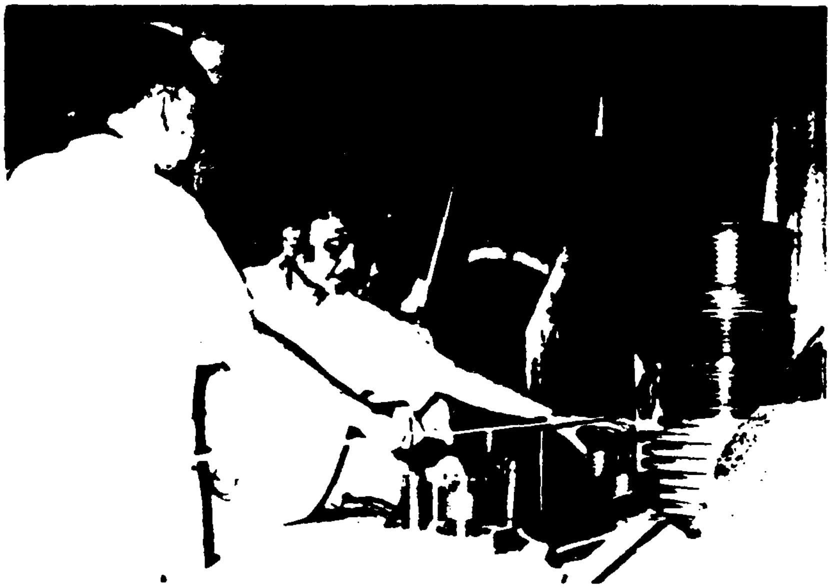
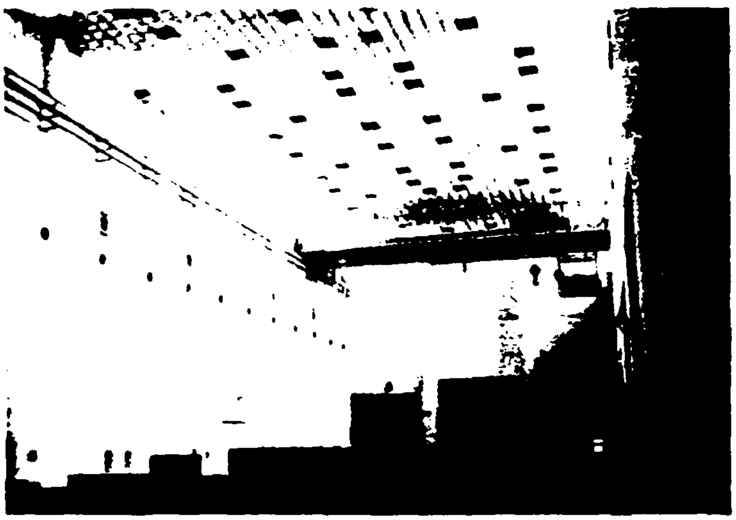


毛泽东参观探空火箭
Mac Zedong inspects sounding rocket



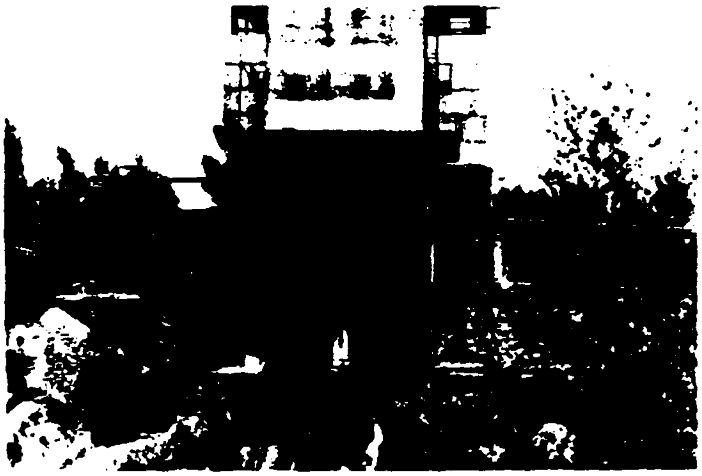
邓小平参观运载火箭
Deng Xiaoping inspects carrier rocket

火箭总装车间
Rocket final assembly shop



卫星装配厂房
Satellite assembly room

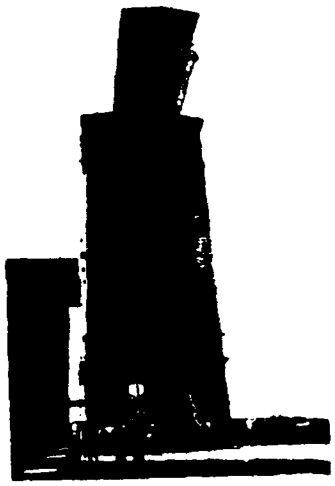
洞室工程
Underground engineering room



火箭发动机试车台
Rocket engine test stand

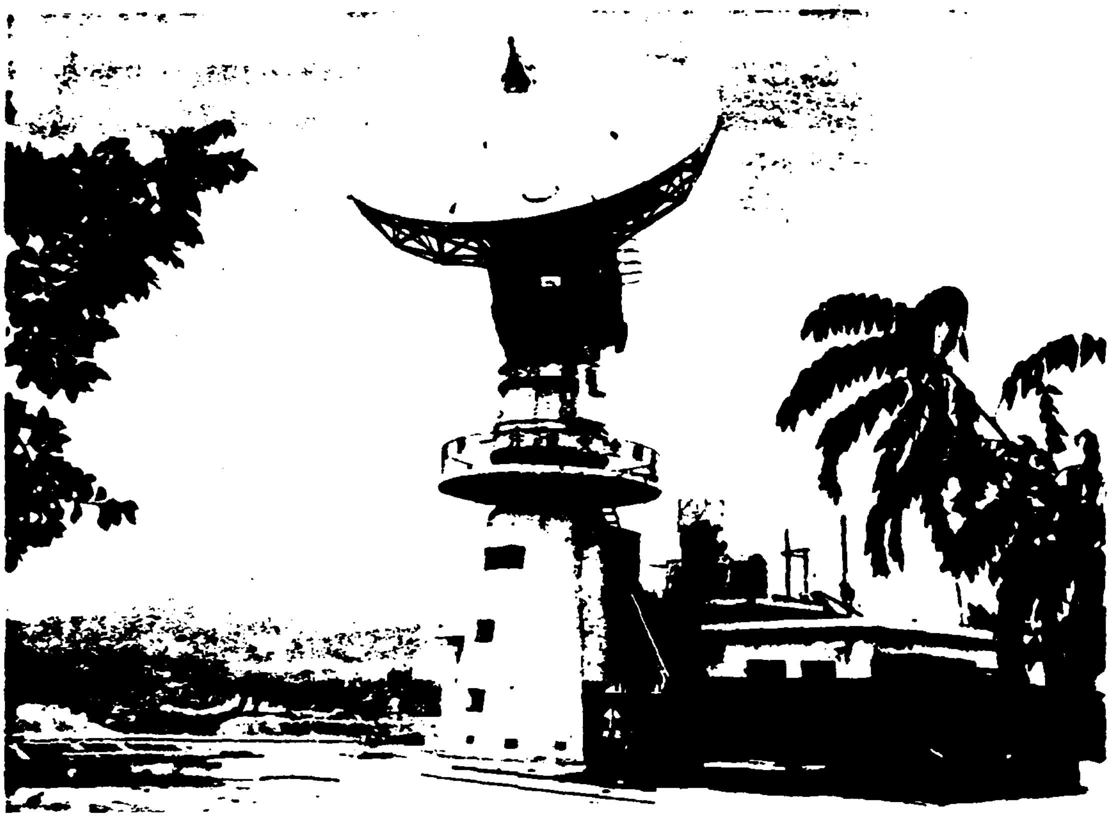
吊装试验通信卫星

Hoisting experimental communications satellite



全箭试车台

Entire rocket test stand



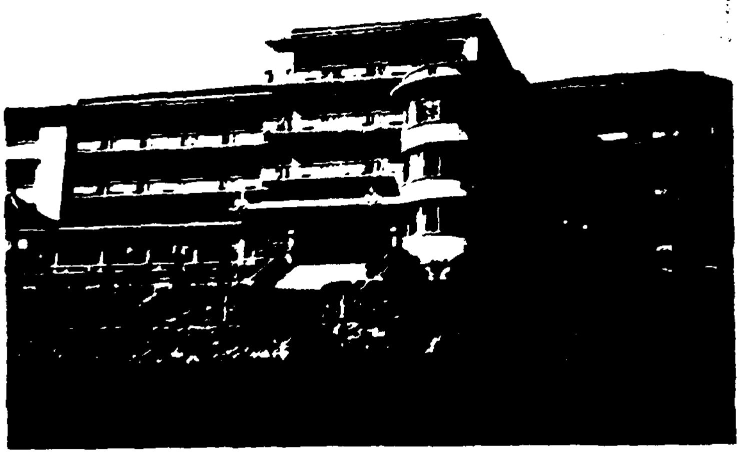
微波统一系统及其机房外景

Exterior view of integrated microwave system and its equipment building

航天工业部第七设计研究院(基建)

设计研究楼

Ministry of Space Industry, Seventh Design and Research Institute (capital *construction) Design and Research Bldg.*



航天工业职工疗养楼

Space industry treatment and convalescent center

TAPPING POTENTIAL, INNOVATION, AND TRANSFORMATION FOR RAPID ADVANCEMENT OF AVIATION TECHNOLOGY [PAGE 195]

The period from 1977 to 1985 was the time that China's aviation industry tapped potential, introduced innovations, and carried out transformations to realize rapid technological advances.

In October of 1976, with the break up of the "Gang of Four," the Cultural Revolution came to an end. China's efforts to build socialism entered a new historical phase. In order to recover lost time and to reduce the gap between our aviation technology and the advanced levels world-wide, the aviation industry's capital construction concentrated its forces to implement the necessary rebuilding and expansion, focussing on three major experimental missions: The launching of a large, long-range carrier rocket, underwater launching from a submarine of a carrier rocket, and an experimental communications satellite.

1. The Arduous Mission

Because of the destructive interference of the Gang of Four during the ten years of the Cultural Revolution, the three major experimental projects mentioned above could not be implemented according to plan. After the destruction of the Gang of Four, in 1977, the Chinese Communist Party's central committee approved the report of the chair of the National Defense Scientific Committee, Zhang Aiping, concerning the realization of the above three programs, and required that the aviation industry consolidate its wisdom and efforts, boldly scale the summit, and industriously complete its mission as swiftly as possible.

China's aviation industry had by that time gone through twenty years of construction and development, and had at its disposal certain capabilities in developing, planning, experimentation and production. It had accumulated a certain amount of experience, and had built up a capable research and production team. Nevertheless, if it was to complete the three major experimental tasks and achieve a great advance in aviation technology, it had

to surmount a whole series of difficulties with new technologies, new materials, new fuels and so on. For this purpose, it was first necessary to establish new conditions for research, experimentation and production. The launch of the experimental communications satellite, for example, was a cooperative system project larger in scale than the launch of any previous satellite; the technology was very complex, and the degree of difficulty was extremely high. Communications satellites are chiefly used in receiving and transmitting radio signals for telephonic communications and radio and television broadcasts; they serve the function of relay stations. In addition, they have been developed as a modern means of communications internationally since the 1960's. The most important characteristic of this kind of satellite is that its orbit is a circular orbit within the plane of the equator (that is, a circular orbit in the space over the equator). Its orbital direction is the same as the direction of the earth's rotation; and its orbital period is exactly the same as the period of the earth's rotation. The altitude of the orbit is approximately 36,000 kilometers, and the satellite moves around the earth at a speed of 3.075 kilometers/second. Thus, when observed from the surface of the earth, the satellite appears to be static. To launch the communications satellite, a multi-stage carrier rocket with a large thrust was needed in order to carry the satellite into an elliptical orbit near the earth (a "berthing" orbit); and then to carry it into a larger elliptical orbit at a point further from the earth (a transfer orbit), then a standard synchronous orbit (a drift orbit), and finally a fixed position in the synchronous orbit (static orbit). It is thus necessary to change the orbit a number of times between launch and fixed position. The engine must ignite a number of times, and the attitude of the satellite must be adjusted and corrected a number of times with extreme accuracy. Under ordinary conditions, a half month or longer is needed for the process. The satellite communications system is composed of communications satellites and earth-side stations. Since July 1963, when the United States launched its first earth-synchronous fixed-point communications satellite, the Soviet Union, Japan, and a European consortium of eleven countries organized around France have one after the other mastered the technology for launching the synchronous fixed-point communication satellite. The engineering work for the

communications satellite includes five major systems: The satellite itself, the carrier rocket, the launching pad, surface control, and surface stations. For the satellite, subsystems include structure, power source, control, communications, remote control, tracking, antennas, temperature control, and apogee engine. After the launch, it is necessary to determine the satellite's orbit, and to control the satellite's orbit in flight; a series of earth measurement and control stations must therefore be built. The long period of time that the satellite works in space (internationally three to five years) makes necessary not only advanced techniques of planning and construction, but also trials of life expectancy, and of the ability to withstand the adverse conditions of space. Therefore, the components of the satellite, and the satellite itself, must be put through many experiments and trials that simulate the conditions in space, like a vacuum, cold darkness, magnetic fields, tiny meteors, solar wind, particle radiation, and so on. For this, it is first of all necessary to construct many kinds of experimental equipment able to simulate the environment of space.

All personnel involved in the aviation effort, in order to complete the three major experimental missions, mobilized energetically and eagerly made up for lost time. They made possible the great technological leap in aviation. The capital construction force was, as it were, the reserve army, as well as the vanguard; their mission was still more arduous and urgent.

2. Exploitation of Hidden Assets, Establishing New Conditions for Development

In order to guarantee the conditions for implementing the three major experimental missions, beginning in 1977, after repeated research and level-by-level investigations, all units together proposed over 60 urgently needed rebuilding and expansion projects covering a construction area of 100,000 square meters. In February 1978, with the approval of the National Planning Committee, the entire set of projects was designated as a key national construction project, to be organized and constructed as large or medium projects. All aspects of the project, including manpower, material, and financial requirements, received strong support.

The Ministry's Construction Planning and Research Institute, the Survey Company, the Construction Engineering Company (incorporated into the seven mechanical ministries system from the Construction Ministry in 1976), the Installation Engineering Office, and the Thirty-Sixth Detachment of Capital Construction Engineers, organized especially for the construction projects of the aviation industry in 1976, bore the greater part of the construction responsibility. The design institutes, equipment installation companies, construction engineering companies and railway corps of the affected localities also cooperated on a large scale. After one or two years of united efforts, a number of essential research and production construction programs were completed one after another, providing the conditions for research in a timely manner. For example, in 1978, there were completed over ten research and production projects, including the antenna direction experimental field, the load simulation laboratory, the system simulation laboratory, and the low-temperature laboratory. Again in 1979, another ten or more projects were completed, including machining of the antenna wave guide, production of liquid nitrogen, the "450" antenna field, vibration measurement experimentation, spray application foaming, and the non-metallic experimentation. Others, like the experimentation field for development of the new model engine, the satellite general installation factory, the high and low temperature experimentation, the solid fuel carrier rocket general installation factory, the comprehensive satellite experimentation, the large-scale space simulation experimentation, and so on, were also completed in succession during this period and handed over for use. Among these were many programs that, because of the complexity of the technological requirements and the need for accuracy, presented new problems in construction engineering technology. In addition, the technology for research and experimentation was itself a matter of feeling our way, so that these programs were implemented with a combination of research, planning, and construction carried on night and day--and yet, they were all successful.

The "450" antenna field is the experimental locality for a microwave unitary measuring system, an important component of the communications

satellite system developed along with it. In 1979 the basic construction was completed, and in 1981 the system underwent composite trial and calibration. This project includes two antenna bases; one requirement for it is that, after two months of normal operation, the inclination and subsidence of the bases be less than 0.3 millimeters, and that the long-term inclination and subsidence be less than 3 millimeters. The requirements for the horizontal stability of the linking position of the antenna structure rotation platform on top of the bases are especially stringent (maximum movement is five parts in 10,000, or 1.5 millimeter). After meticulous planning and construction, the top of the number 1 base was found in the end to be in fact within 0.2 millimeters of the horizontal (based on reference material, the international standard allowance for deviation in similar antenna base tops ranges from 0.3 to 0.45 millimeters). The requirements for use were completely satisfied, and the main technological and economic indicators attained the advanced levels of similar projects both at home and abroad.

The high-altitude simulation test-run unit is used in high-altitude simulation experiments for the communications satellite orientation control motor. That it fulfill the conditions for vacuum testing of the engine is a critical element in its design. Because of the high temperature and speed and the great quantity of gases and poisonous, highly corrosive combustion products produced by the engine during experimentation, the condition that a vacuum be maintained occasioned a whole series of problems. The designers used advanced technology and practical, effective measures to bring the technological performance up to advanced international standards; this is an important breakthrough in our aviation experimental technology, and contributed greatly to our success in launching the communications satellite. This project, in addition to encompassing items like the high-altitude ignition of the orientation engine, shut-off, orientation simulation trial runs, and so on, also included the installation of high and low temperature installations, a data simulation device, and the completion of a waste water management installation; the time required for the entire project was only twenty months.

The experimental flight-correction tower used for ship-board antenna debugging was completed in a space of les· than two months. The construction of the entire hydrogen/oxygen engine development experimentation area also required only 20 months before it was ready for use. The comprehensive satellite testing laboratory's circular, movable canopy which can be opened in several directions, was researched, tested, developed, constructed and installed entirely by the project technicians themselves.

For the construction of the large space simulation mechanism and its experimental factory, the relevant units were many times organized to cooperate in the building, debugging, installation; up to 100 units were working on it at once. To guarantee the experimental vacuum requirements, it was necessary to implement thermal treatment on a stainless steel flange 7.5 meters in diameter, as well as to ensure that the 19 450-millimeter-diameter holes on the seal were parallel within two centimeters. With the cooperation of more than ten units, only six days were required from the demonstration to the completion of the processing technology, including the preparation of the more than twenty kinds of material needed and the construction of a large thermal treatment furnace 9.5 meters in diameter. The large space simulation mechanism is like a large, high vacuum building; it is capable of a vacuum of 10^{-8} millimeters of mercury, and is composed of seven major systems, including a vacuum system, a liquid nitrogen system, computerized data inspection and a processing system. Its experimental capacity is over 400 cubic meters; there are only a few nations in the world today that have similar simulation installations.

In the work of rebuilding, expansion and construction, the "450" antenna experimental field and the solid rocket general installation factory received national recognition for excellence in design.

It is just because forces were concentrated, because of pooling everyone's wisdom and efforts, that these new development projects were completed and handed over for use in a timely manner, guaranteeing the

triumphant completion of the aviation industry's three major experimental tasks.

3. Adjust the Investment Direction, Heighten Investment Benefits

After 1978, based on the requirements for national adjustment of capital construction, at the same time as the aviation industry was completing its rebuilding, expanding, and constructing projects to establish the conditions for the three major experimental tasks, the work of ordering and rationalizing construction projects was being pursued vigorously, and the direction of investment was being gradually adjusted, greatly raising the benefits of capital construction investment.

In 1980, after the ordering of construction projects, a total of 21 projects were postponed, including 13 large-scale projects, saving over 500,000,000 yuan in capital investment.

Concerning construction projects in the interior that had already been completed, an organization was set up for the checking and acceptance of completed work at all levels. Based on putting finances in order and ordering and filing project materials, acceptance for finished projects was organized by stages and in groups. By the end of 1985, over 70 completed projects had been accepted, and the procedures for transference of fixed assets were carried out. Concerning remaining inland construction problems, especially research and production systems, living and welfare facilities, and water and power supplies, a certain amount of investment was set aside every year to deal quickly with loose ends, producing even greater benefits.

At the same time, since 1977, capital construction in the aviation industry gradually expanded the proportion of investment used for reconstruction, expansion, and building projects and technological renovation. In 1977 the amount in the national budget for technical renovation and reconstruction, expansion and building projects represented 43.2%; in 1985, it had grown to 72.5%. In the composition of investments, there was great

emphasis on the development of the intellect and talent. During the sixth Five-Year Plan, the construction investment related to education was 2.1% in 1981, but had climbed to 10.4% in 1985. The Aviation Industry Ministry's own comprehensive Technical University, the Aviation Industry Institute, the Cadre Advanced Studies Academy, the Workers and Staff University, technical schools of all kinds, mechanical schools, and elementary and high schools at all base localities were given a great impetus; advanced study centers to train high-level technical personnel were also prepared, basically forming an educational system for the aviation industry. The conditions for learning were greatly improved, and the material conditions for self-reliant development of scientific and technical aviation industry personnel were established.

Beginning in 1977, investment for construction of housing and welfare facilities for workers and staff increased year by year. During the sixth Five-Year Plan, the average annual investment for construction of housing represented about 35% of the total capital construction expenditure. Theaters on which construction had ceased twenty years earlier were now completed; every research institute one after the other built theaters for movies and plays, green areas, young people's science museums and other cultural facilities. From 1981 to 1985, there was a total of 1,500,000 square meters of newly constructed dwellings, equivalent to 30,000 apartments. To carry out the task of constructing housing, the leadership as well as the workers and staff of the units involved were instrumental; they set up small groups for housing construction leadership, and on the principle of division of labor set up specialized groups for planning, design, relocation, construction, and other purposes. The speed of construction was greatly enhanced. For example, in the Beijing area there were two residential districts in which over 1,400 households were relocated; all relocations were carried out according to plan, and the work commenced on schedule. Those multi-story residences on which work began in 1984 could be completed and transferred for use in approximately 10 months.

At the same time as China's aviation research and production were being developed, integration of the army and the people was being actively and

thoroughly carried out; the production structure was being adjusted, and excellence in technology and potential for research and production were being brought into play. The production of consumer products was being developed, and a transformation from the "military work only" pattern to a "military/civilian integration" pattern was being realized. With a relatively small outlay of funds, the necessary reconstruction, expansion and construction were implemented. During the sixth Five-Year Plan, the value of industry and business consumer products was budgeted to increase on the average 54% annually. The projects for the production of consumer products include several hundred varieties, such as petroleum, chemical engineering, communications, electronic appliances, light manufacturing, numerical control machine tools, earth-side satellite reception stations, medical equipment, high-power accelerators, robots, and items for daily use. A number of these products fill gaps in our national production; some are in great demand throughout the country, and even have found a foreign market. Some have won national awards for high quality.

On the basis of the bitter lessons gained from the Tangshan earthquake, in order to ensure the safety of aviation industry personnel and the protection of equipment (especially valuable special-purpose equipment), anti-earthquake reinforcement procedures have been implemented for all kinds of buildings and structures in earthquake zones, according to the intensity of earthquakes to which the zone is subject. Offices for anti-earthquake reinforcement have been set up at all levels; in addition to certain supplements provided by the national government, they provide a certain amount of special funds and material every year to be used for reinforcement work. The design institutes have set up special design groups and reinforcement technology research groups to develop innovations in the technology. During construction, they ensure that reinforcement measures as well as research and production are in order. By the end of 1985, the task of reinforcing 3,300,000 square meters of building area had been completed, representing 85% of the area that required reinforcement. A total of 44,000,000 yuan had been invested. In addition to reinforcement, this activity also remedied original construction flaws, improved the conditions of use, raised the users' sense of

security, and achieved economic, social, and environmental benefits. A large number of units and individuals with advanced anti-earthquake reinforcement capabilities emerged, and an important fund of experience was obtained. The Aviation Industry Ministry was recognized as an advanced anti-earthquake reinforcement unit, and was awarded a national commendation.

In the area of environmental protection, the principle of "plan, construct and use simultaneously" was actively put into practice. During the sixth Five-Year Plan, 26,000,000 yuan were set aside for environment management, and over 700 management measures were completed. Forty-five management projects were built; a number of institutes, bureaus and bases built and perfected environmental monitoring stations and study organizations; the results of some of their investigations won the National Science and Technology Advancement Award. The Aviation Industry Ministry has basically formed a contingent for the monitoring, control, scientific investigation and management of the environment.

4. The Reform Policy for Continued Progress

Based on the national spirit of reform in the capital construction management system, the aviation industry's capital construction has taken gratifying strides and achieved a certain success in the areas of inviting and submitting bids, investing for complete projects, engineering contracting, reallocating funds, responsibility for completion of construction (100 yuan output value/wage content), the system of surveying and design units undertaking technological and economic responsibility, enterprise-style management, strengthening project quality control, and human development.

In aviation industry construction, international exchange and the import of advanced foreign technology have been emphasized. Since the beginning of the 1980's, newly developed production projects, completed and under construction, include the chromium plating production line, the large-scale twining workroom, main-frame computers, large-scale integrated circuits, multi-layer printing plate production, and the copy center.

Aviation technology is an important field in the contemporary world-wide technological revolution. It holds great promise for development. China's aviation technology has completed the task of first-generation product development, and is now at the critical moment of changing direction toward the task of second-generation product development. Aviation industry capital construction, now and in the future, continues to face an enormous mission. It is necessary to continue to open up new territory and to advance, and to continue to make new contributions.